



Conceptual optimal design of jackets

Sandal, Kasper; Verbart, Alexander; Stolpe, Mathias

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Sandal, K., Verbart, A., & Stolpe, M. (2016). *Conceptual optimal design of jackets*. Poster session presented at 13th Deep Sea Offshore Wind R&D Conference, Trondheim, Norway.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Conceptual optimal design of jackets

Kasper Sandal, PhD student, kasp@dtu.dk
Alexander Verbart, Mathias Stolpe

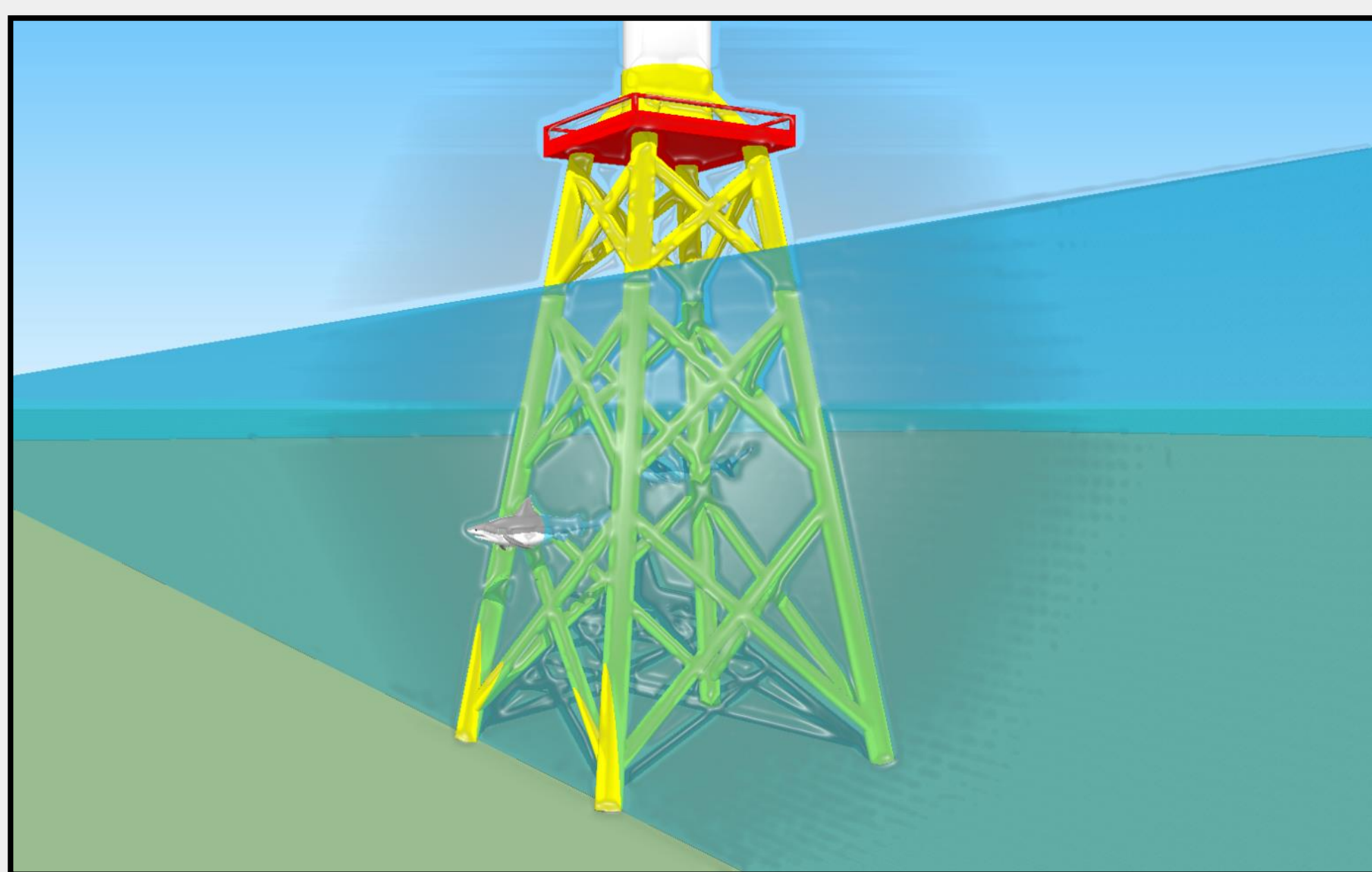


Figure 1: A jacket in its natural environment.

Motivation

Conceptual design describes the jacket in rough terms [1], such as height, width, and number of legs. This study investigates the influence of leg distance on optimized jacket mass.

Model & Software

In the research project ABYSS, a Timoshenko beam finite element software, JADOP, is developed for structural optimization of jackets. Main features of JADOP are

- Analytic sensitivities
- Parametric jacket topology
- Realistic wind and wave loads
- Fatigue post processing
- Stress concentration factors
- Advanced optimization

Optimization problem

Minimize the mass of a jacket, subject to fatigue constraints:

minimize $f(x)$	Objective (mass)
subject to $K(x)u - \Delta P = 0$	State equation
$\underline{\sigma} \leq \Delta\sigma(x) \leq \bar{\sigma}$	Fatigue (stress)
$\underline{\lambda} \leq \lambda_1(x) \leq \bar{\lambda}$	Frequency
$\underline{x} \leq x \leq \bar{x}$	Design variables
$\underline{u} \leq u \leq \bar{u}$	State variables

where x describes all the cross sections in the jacket, and $\Delta\sigma(x) \leq \bar{\sigma}$ is a fatigue equivalent stress constraint.

Structural optimization can explore a large design space (400 jackets) in a short time (2 hours), and thus lead to better conceptual jacket designs.

The influence of leg distance on jacket mass

400 conceptual jacket designs with small changes in the top and bottom leg distances are created and optimized in JADOP. Figure 2 and 3 shows two of them. Figure 4 shows the trends for mass and frequency.

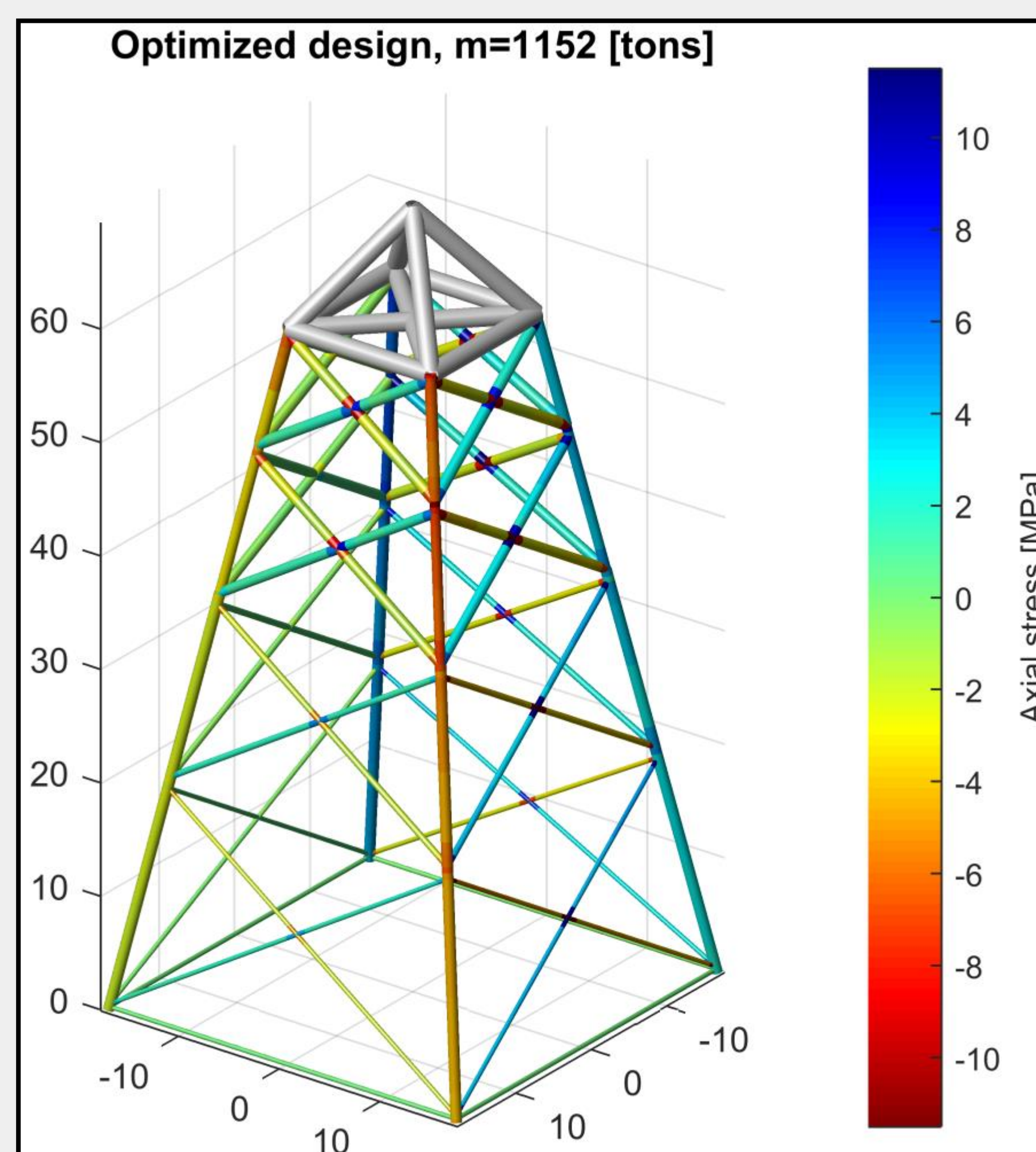


Figure 2: The Innwind reference jacket has a bottom and top leg distance of 34 and 14 meters, marked with a blue circle in Figure 5.

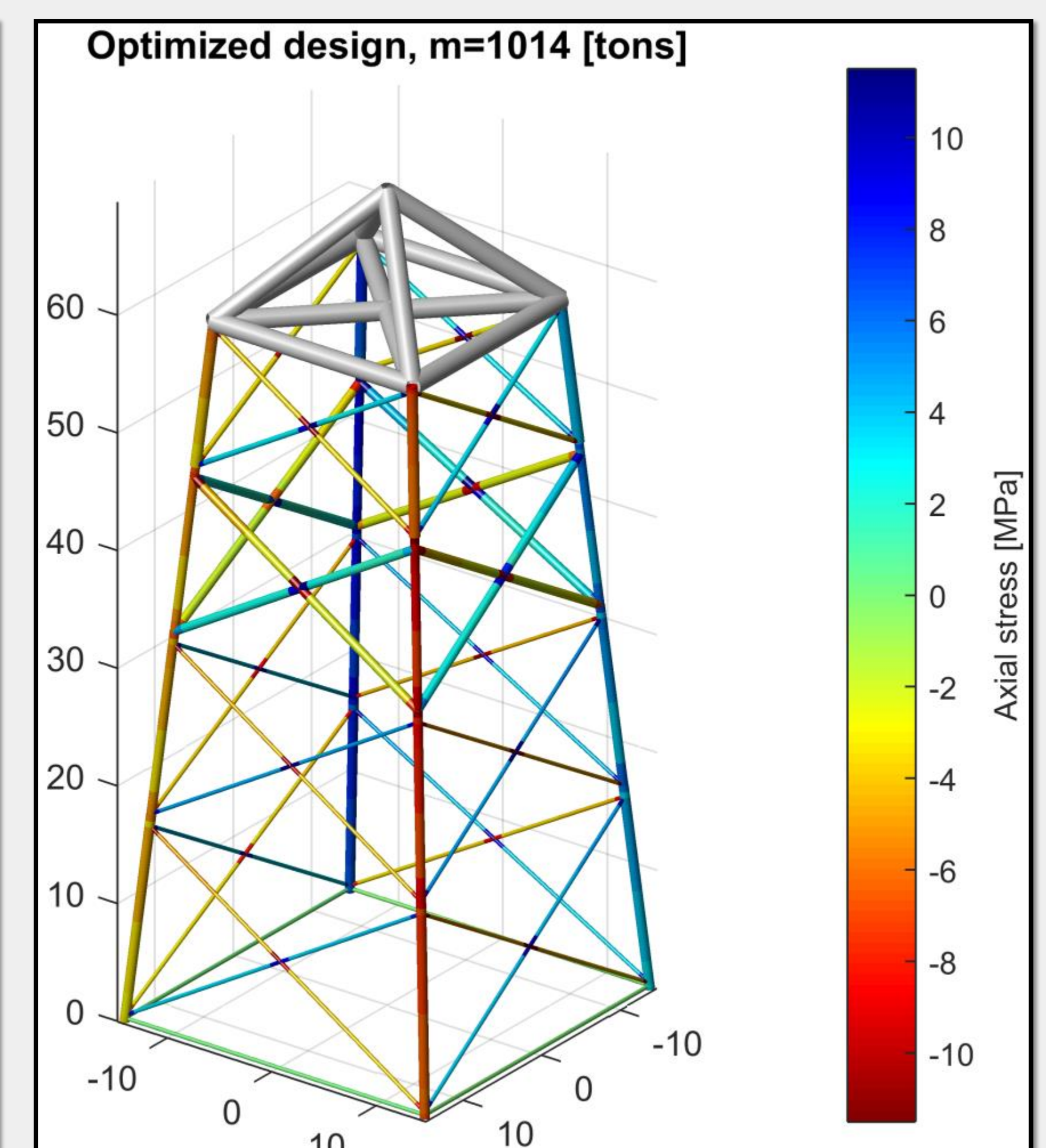


Figure 3: The new conceptual jacket has a bottom and top leg distance of 28 and 19 meters, marked with a red star in Figure 5

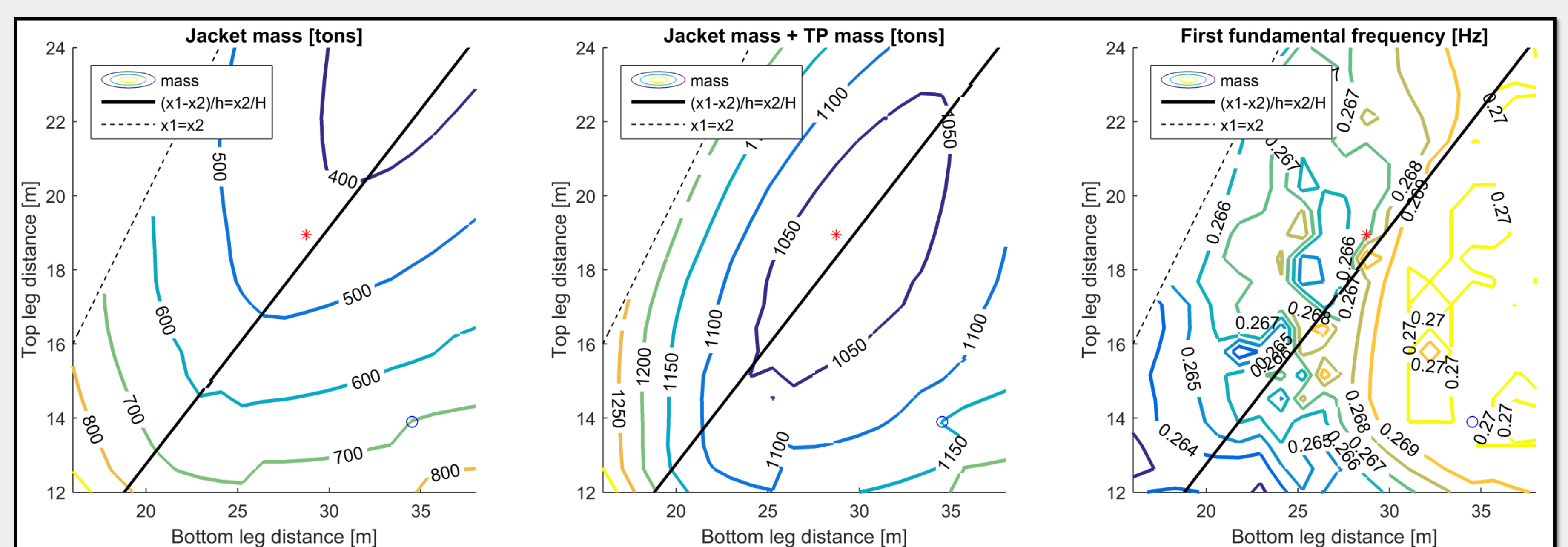


Figure 4: Three contour plots showing how the leg distance influences the optimal design of the support structure. Note how larger leg distance really influences the jacket mass, while frequency is almost unchanged. The black line indicates jackets where the extended legs would meet at the tower top.

References

- [1] Marc Seidel. State-of-the-art design processes for offshore wind turbine support structures. Stahlbau, 85(9):583–590, 2016.
- [2] Thomas von Borstel. Design report - reference jacket. Technical report, 2013
- [3] A Waechter and L T Biegler. On the Implementation of a Primal-Dual Interior Point Filter Line Search Algorithm for Large-Scale Nonlinear Programming. Mathematical Programming, 106(1):25–57, 2006.